Information Services Markets Artificial Intelligence 1985-1990

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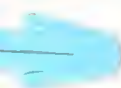# INFORMATION SERVICES MARKETS
ARTIFICIAL INTELLIGENCE
1985-1990

INFORMATION SERVICES MARKETS

ARTIFICIAL INTELLIGENCE

1985-1990

CONTENTS

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INFORMATION SERVICES MARKETS
ARTIFICIAL INTELLIGENCE
1985-1990

EXHIBITS

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I INTRODUCTION

A. PURPOSE OF THIS REPORT

- This report is produced as part of a series of reports in INPUT's Software Markets Program, which is part of the Market Analysis and Planning Service (MAPS) series.

- The report provides an overview of the leading applications areas in artificial intelligence and takes a look at some of the key vendors and their operations to date.

- The market for artificial intellligence is still in its infancy, but the value of applying this relatively new technology to satisfying future business needs is apparent in today's examples.

- As businesses recognize the potential benefits of automating information, applications become more complex. The expanding domain of management end users has given rise to demand for decision support. The falling costs of hardware has opened doors to new applications in the personal use of computers.

- The importance of artificial intelligence is undeniable. The state of the artificial intelligence market as a source of revenue for vendors is the issue this report explores.

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B.   SCOPE AND USE

- This report zeroes in on the artificial intelligence market niche by starting with a summary of the market, then focusing on the participation of leading vendors in the market, and finally profiling the operations of selected vendors in the market.

- This report is written in a quick-reading format for senior marketing executives, product managers, and strategic planners in the information services industry.

- This report focuses on applications in the artificial intelligence market.

  - Artificial intelligence (AI) is a term originally used to describe the academic discipline from which computer applications in this area originated.

  - Applications that are frequently referred to as artificial intelligence include:

    - Expert systems.

    - Expert systems generators.

    - Natural language systems.

    - Programming languages like LISP and PROLOG.

    - Speech understanding.

    - Speech recognition.

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- Vision systems.

- Robotics.

- Many of these applications categories lend themselves to programming methodologies other than AI, despite the fact that people have developed some of them using AI.

  - Sight interpretation in commercial applications usually involves pattern matching rather than AI methods.

  - Similarly, speech recognition also involves pattern matching and lends itself to algorithmic approaches.

  - The category of robotics typically involves sight interpretation and some movement algorithm.

C.   DEFINITIONS

- Expert systems applications are real-time, interactive computing applications that organize a person's knowledge into several basic "if-then" structures which are then grouped, depending on the system's inputs, into an active decision tree. This "active" decision tree is sometimes referred to as the cache, the global data base, the knowledge base, or the working memory.

- Expert systems generators are application development tools that aid the systems programmer (or end user) in developing knowledge-based expert systems.

  - An expert systems generator is, typically, a relational data base management system modified to manage the organization of the basic

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"if-then" structures that make up the knowledge base in expert systems applications.

- Some tools are meant to be used by experienced LISP or PROLOG programmers. Others are for end users to develop prototype systems or systems that handle smaller problem domains. The latter is referred to here as "example-based" systems, because after the end user defines a system structure (similar to defining a file structure in a relational data base management system) he or she enters examples of cause-effect situations to generate the expert system.

- Natural language systems can be thought of as expert systems that understand all about the grammar and vocabulary of a written language and are able to translate the written word into a command syntax understandable by a computer.

D. METHODOLOGY

- In-depth interviews were conducted with specialized vendors in the artificial intelligence market. Additional interviews were conducted with larger hardware and information services vendors participating in this field.

- A copy of the questionnaire used is included in Appendix C.

- Secondary sources from more than twenty different periodicals, newspapers, and government reports were used for additional information concerning trends and applications developed in AI.

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E.   RELATED INPUT REPORTS

●   Recent INPUT reports related to this one include:

-    <u>Decision Support Systems and Beyond.</u>

-    <u>Information Services Vertical Markets, 1984-1989.</u>

-    <u>Artificial Intelligence and Expert Systems.</u>

-    <u>Market Impact of New Software Productivity Techniques.</u>

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II EXECUTIVE SUMMARY

- This executive summary is designed in a presentation format in order to:

    - Help the busy reader quickly review key research findings.

    - Provide a ready-to-go executive presentation, complete with script, to facilitate group communication.

- The key points of the entire report are summarized in Exhibits II-1 through II-7. On the left-hand page facing each exhibit is a script explaining its contents.

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A.　WHAT EXACTLY IS ARTIFICIAL INTELLIGENCE?

- The publicity given to artificial intelligence (AI) over the years has greatly distorted the perception of computers among the public. In particular, the term "AI" usually conjures up notions of emotionless machines making logical decisions without the aid of human intuition. In actuality, artificial intelligence refers to the study of the processes by which humans perceive and assimilate data (and use reasoning to process this data) for the purpose of duplicating these processes within computer systems. Artificial intelligence also refers to the computer systems that accomplish these duplicated processes.

- AI computer systems execute interactive processes; they analyze dynamic data inputs that may change over time. The main AI categories--natural language systems, expert systems, and speech understanding systems, all process data interactively. Computer systems are also real-time processes. The data inputs they receive are active in real time and require response in real time.

- Finally, AI computer systems have self-modifying flow controls (i.e., the flow of processes in an AI system may change depending on the inputs). In an expert system, this would involve the addition of "if-then" statements to the program as the system is learning new relationships about the data. The data structure itself is also dynamic: its organization is modified, based on past inputs and conclusions.

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EXHIBIT II-1

WHAT EXACTLY IS ARTIFICIAL INTELLIGENCE?

- **The Study of the Automation of Human Perception and Reasoning**
- **The Computer Systems That Apply the Theories Under Study**

AI Computer Systems:

- **Process Data Interactively**
- **Are Real-Time Processes**
- **Have Self-Modifying Flow Control**
- **Have Dynamic Data Structures**

B.   ARTIFICIAL INTELLIGENCE SERVICES MARKETS

- The markets for artificial intelligence computer services include software products and services related to the development of computer systems that have software as a major component. The application areas included in this market follow.

- Expert systems applications (e.g., MYCIN, DENDRAL), the initial focus of vendor efforts, contain specialized factual and heuristic knowledge that when applied to inquiries by end users, is used to make logical inferences or deductions for responding.

- Expert systems generators (e.g., KEE, S.I, ART) are application development tools used to facilitate the design and implementation of expert systems applications.

- Symbolic programming languages (e.g., LISP) manipulate symbols and handle strings of information. In addition to being useful for solving algebra problems, symbolic programming languages are useful for parsing natural languages in artificial intelligence.

- Logic programming languages (e.g., PROLOG) are designed for programming that uses a lot of logical operations in processing data. These languages are useful for handling rule-based applications like expert systems.

- Natural language systems (e.g., INTELLECT, EASYTALK) receive as input typed natural language (i.e., English, French, German, etc.) statements and translate these statements into a command syntax that the computer can understand.

- Speech understanding systems (e.g., HEARSAY II, HAPPY), still in the laboratory, are natural language systems that receive as input spoken natural language statements. Interpreting dialects and intonations in spoken languages introduces additional complexity in syntax translation.

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EXHIBIT II-2
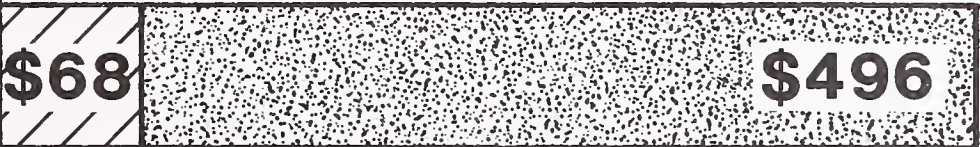
ARTIFICIAL INTELLIGENCE SERVICES MARKETS

- **Expert Systems Applications**

- **Expert Systems Generators**

- **Symbolic or Logic Programming Languages**

- **Natural Language Systems**

- **Speech Understanding Systems**

C.   A.I. MARKET EXPLODING

- During 1984, approximately $65 million worth of artificial intelligence appli-
cations were delivered. INPUT estimates that in 1985 this market will reach
$115 million and that, by 1990, artificial intelligence applications will have
grown to $885 million, reflecting an average annual growth rate of 50%.

- Expert systems (ES) generators represent the fastest growing area of AI,
averaging an annual growth rate of 63%. This is because the nature of expert
systems applications requires extensive customization to meet each user's
application; therefore an ES generator has far greater immediate value than
ES applications aimed at vertical markets, which will take longer to develop.

- Much of the future growth in expert systems applications will be aided by the
rapid emergence of expert systems generators that help programmers develop
these applications. In the process, the definition of an expert systems gener-
ator will blur into applications as function-specific and industry-specific
generators enter the market. As a result, the software products AI market
will grow to $195 million by 1990.

- By 1990, expert systems applications will be the largest sector of the AI
market. User expenditures for these applications, driven by high demand for
software and professional services from the manufacturing, banking and
finance, and federal government vertical market segments is expected to
grow from $55 million in 1985 to $455 million by 1990.

- Professional services in artificial intelligence is the largest delivery mode,
with $68 million in user expenditures expected for 1985. This market is
expected to grow to $496 million by 1990, reflecting an average annual growth
rate of 49%.

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EXHIBIT II-3

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A.I. MARKET EXPLODING

By Delivery Mode, 1985-1990 ($ Millions)

Delivery Mode	User Expenditures ($ Millions)	1985-1990 AAGR
Processing Services	$15 / $62	33%
	☐ 1985	
	▨ 1990	
Software Products	$20 / $195	58%
Turnkey Systems	$13 / $133	59%
Professional Services	$68 / $496	49%

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D.   A.I. POSITIVE GROWTH FACTORS

•   In 1982, the Japanese government announced its "Fifth-Generation" project, which merged government and business into an economic force aimed at making the Japanese a dominant factor in AI applications development. Although many press articles have downplayed the Japanese effort, serious observers recall a time when most televisions, videocassette recorders and automobiles were manufactured domestically and foresee a similar threat to U.S. industry.

•   As the price/performance ratio of high-powered supermicros continues to decline, it becomes more economically feasible to develop artificial intelligence applications. The Department of Defense (DoD) was interested in AI applications long before the term "AI" was invented, and the DoD continues to fund many of the applications being developed on the "cutting edge" of technology.

•   AI is gaining recognition by certain vertical market users as a competitive weapon for managing information. In particular, the banking and finance segments, insurance, and manufacturing are funding the development of expert systems to make their businesses more competitive.

    -    Dow Jones News Retrieval Services has a multiple data base access system (developed by Brattle Research).
         Battele

    -    Applied Expert Systems and Syntelligence say they are developing systems with clients in the finance and insurance industries.

    -    Teknowledge is working with General Motors on a diagnostic expert system.

    -    McDonnell Douglas Knowledge Engineering is working with a major brokerage firm on a stock advisory system.

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EXHIBIT II-4

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A.I. POSITIVE GROWTH FACTORS

- **Japanese "Fifth-Generation" Project Perceived as Threat to U.S. High Tech Industry**

- **Decreasing Hardware Price/Performance Ratio of Supermicros**

- **High Department of Defense Interest and Funding of AI**

- **Vertical-Industry Recognition of AI as a Competitive Weapon**

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E.   A.I. NEGATIVE GROWTH FACTORS

- There remains much confusion within the user community (and even among researchers) over what AI really is, how it can be applied to the solution of everyday problems in business, and how it differs from operations research (OR) or methods for solving problems within OR. (Linear programming is one such method.)

- Despite the fact that expert systems generators are now available, the cost of purchasing (and just as important, of maintaining) these systems remains high. Packages that may be used by only a select few within an organization run as high as $80,000 for software alone. A further $30,000 for a single user workstation is needed to run that software. Clearly, it would not be easy for a company to decide to invest in these systems, except under critical circumstances, particularly in today's environment of tight budgets and benefit evaluations.

- Finally, there is one additional component in the applications development path, unique to AI applications, that inhibits growth of AI. There is the need for a communications expert who can act as an intermediary between the AI programmer and the bearer of knowledge about the AI application. In expert systems development, this person is frequently referred to as a "knowledge engineer." Without the availability of such specialists, expert systems may come to a grinding halt.

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EXHIBIT II-5

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A.I. NEGATIVE GROWTH FACTORS

- **User Confusion about What Artificial Intelligence Really Is**

- **High Entry and Development Costs**

- **Shortage of Trained Knowledge Engineers**

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F. APPLICATION SOFTWARE COMPONENT EVOLUTION

- Since the beginning of the 1980s, application software has increasingly integrated system software components such as teleprocessing functions, report writers, and fourth-generation languages.

- This trend will continue, and software products will increasingly become a crossbreed of both applications and system software. Data base management systems, micro-mainframe communications, and artificial intelligence will be more closely integrated into applications to provide users with easier access to (and more control over) their data.

- Users have moved from a data-oriented environment into an information-dominated environment. The core features of applications software (the portion that handles the input and production aspects) will continue to take on a lesser percentage of the value of the software.

- As artificial intelligence applications become more prevalent, the knowledge environment in applications will emerge and tools and aids will grow in importance to the applications environment. Overall, the value of tools and aids relative to the core components of a typical applications system will equalize during the next five years.

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EXHIBIT II-6

APPLICATION SOFTWARE COMPONENT EVOLUTION

1980 — Core Features — **Data**
95%   5%

1985 — Core Features — **Information**
90%   10%

1990 — Core Features — **Knowledge**
50%   50%
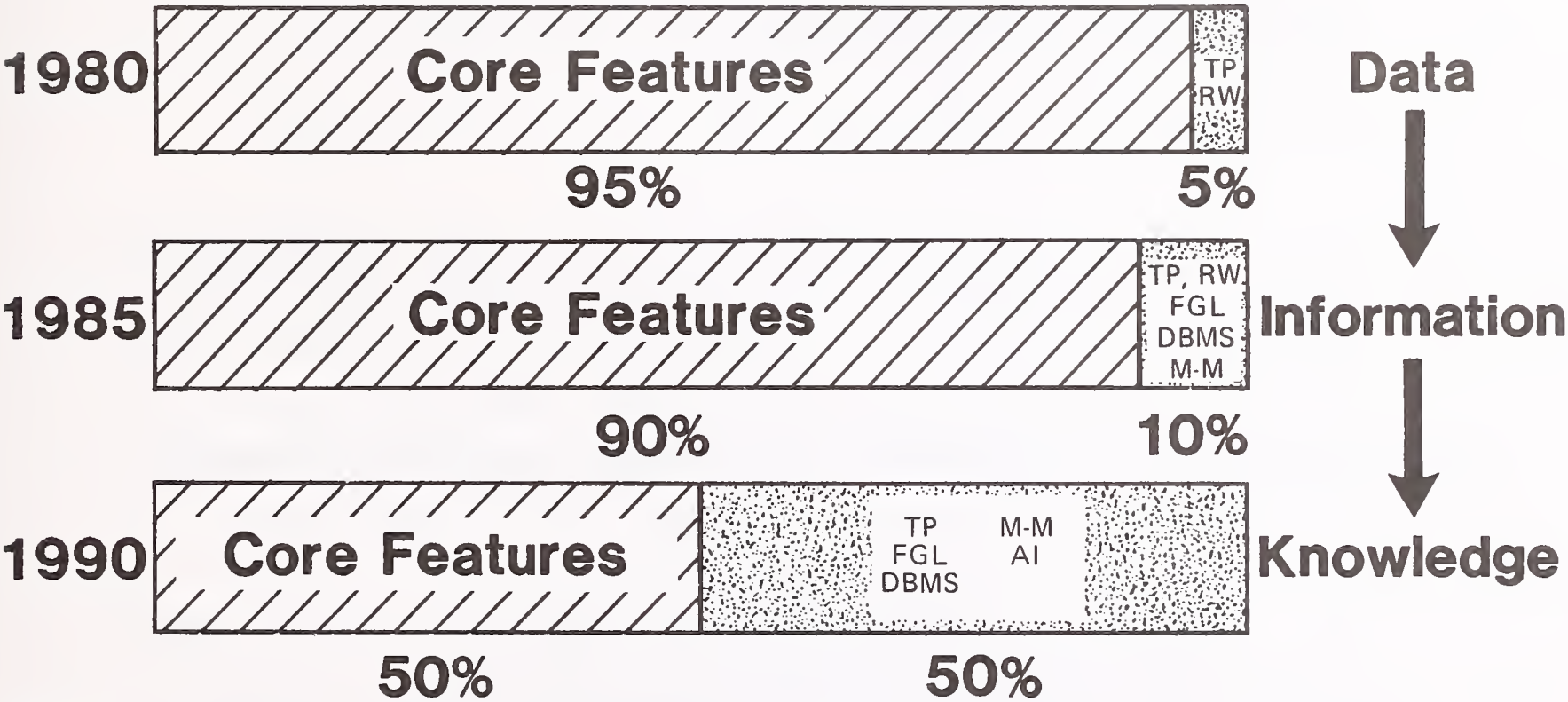
▓ = Systems Software (Tools and Aids)

(TP = Teleprocessing, RW = Report Writing, FGL = Fourth-Generation Language, DBMS = Data Base Management System, M-M = Micro-Mainframe Communication)

Percent = User Perceived Value

G.   A.I. VENDOR RECOMMENDATIONS

- In order to communicate effectively, vendors need to explain to users the usefulness of AI in their own language. It is necessary, therefore, to identify metaphors for AI terminology from well-known data processing and operations research glossaries. Vendors might offer low-cost introductory seminars. Introductory seminars will lower vendors' per-unit sales cost, since too much time is usually spent explaining the basics of AI to potential clients.

- Fortune 500 users lack the technical expertise needed to develop expert systems in-house; vendors who have this expertise lack the experience in developing business applications. Through joint product development, vendors can gain the experience they need to accurately target expert systems applications. To Fortune 500 users, it is more desirable that the generators run on the hardware they already have; in addition, most ES applications that users will be developing with ES generators require access to the corporate data base. Therefore, it is essential that some measure of portability and compatibility be integrated into early ES offerings. In the same vein, it would vastly further the cause of AI vendors if easy interfaces were available for the most common DBMS software products.

- The acquisition and organization of knowledge in an expert system should be such that when new information is added to the system it does not disrupt the system's structure. (Modularity aids maintenance.) Conceptual frameworks that mirror the way people do business are needed in expert systems development to facilitate the user's perception of how AI can be used in day-to-day environments. Similarly, the high cost of expert systems generators is difficult to justify to the prospective AI user. Providing low-cost entry-level generators allows users hands-on exposure to expert systems, without costly investment in hardware and software.

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EXHIBIT II-7

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A.I. VENDOR RECOMMENDATIONS
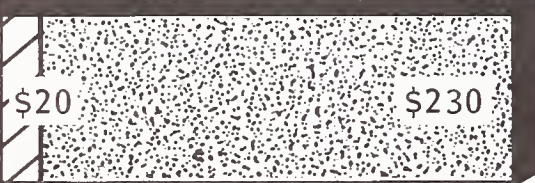
- **Identify Metaphors for AI Jargon**

- **Recruit Major Users into Product Development**

- **Provide Portable, Compatible, Modular Application Systems With DBMS Interfaces**

- **Introduce Conceptual Organization Frameworks and Entry-Level Samples**

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III   MARKET OVERVIEW

- During 1984, $65 million worth of artificial intelligence (AI) applications were delivered. By 1986, demand from corporations, particularly in the aerospace and defense industries, is expected to more than double this amount to $200 million. Over the next five years AI information services will grow at an average annual compound rate of 50% to reach $885 million by 1990.

    - All of the major AI markets are expected to grow steadily (at or above 38%), but the principal area of growth will be expert systems generators, as depicted in Exhibit III-1. This is because the nature of expert systems requires extensive customization to meet each user's application. It is also difficult to define clear application markets, which has encouraged vendors to invest in generators rather than in single applications.

    - The largest AI market after five years will be expert systems applications. The development activities using the applications generators, beginning in 1985, will emerge around 1987 in the form of software packages or turnkey systems.

- The artificial intelligence market for this forecast includes expected user expenditures for:

    - Expert systems applications (the initial focus of vendor efforts).

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EXHIBIT III-1

ARTIFICIAL INTELLIGENCE MARKET
BY APPLICATION, 1985-1990
($ Millions)

APPLICATION	USER EXPENDITURES ($ Millions)	AAGR* 1985-1990
Expert Systems Applications	$55 $455	53%
Experts Systems Generators	$20 $230	63%
Natural Language Systems	$40 $200	38%

☑ 1985 Expenditures

▨ 1990 Expenditures

*Average Annual Growth Rate

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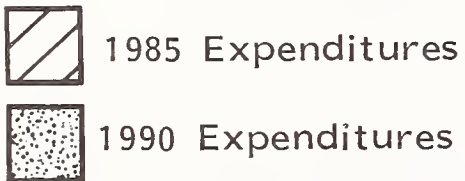
- AI programming languages (which suffer from a lack of standards).

- Speech understanding (which combines speech recognition with expert systems applications and represents a minor market for the duration of the forecast period).

- The forecast specifically excludes:

  - Robotics (such as factory automation).

  - Speech recognition (different from speech understanding in that it does little more than match phonemes to commands).

  - Vision systems (which match stored visual patterns to objects in the field of vision).

  - Specialized hardware sales that do not include value-added software.

A. EXPERT SYSTEMS APPLICATIONS

I. FORECAST AND TRENDS

- The majority of the 1985 AI market will be derived from expert systems applications software and services.

  - Most of these expenditures will be for custom software development services, particularly by the federal government's Department of Defense (DoD).

  - Expert systems application software and LISP and PROLOG language licenses account for the remainder.

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- Expert systems applications are expected to grow at an average annual rate of 53% to become the largest sector of the artificial intelligence market segment. By 1990, this sector will reach $445 million, up from $55 million in 1985.

  - This growth will be fueled by the growth of expert systems generators. As specific vertical-market applications are developed by professional services vendors and user organizations in-house, they will resell these systems to leverage their development costs.

  - In addition, the definition of "expert systems generator" will blur as generators become more directed toward particular applications. As a result, generators themselves will become applications "packages."

- The usefulness of an expert system is realized when a person with little experience can effectively troubleshoot or debug problems that arise in the area of expertise of the system--hence, the term "expert system." For an insightful look at the foundations of AI, see INPUT's Informations Systems Planning (ISP) program report entitled Artificial Intelligence and Expert Systems.

- Some examples of expert systems applications are:

  - Automobile component failure diagnosis (one of the newest applications).

  - Loan applicant risk assessment (experiencing sales difficulty as an AI product).

  - Geological data analysis for oil drilling operations (a classic).

  - Computer systems configuration (DEC's hyped-up XCON).

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- Specialized occupational training for new hires (on the fringes of operations research).

● The emergence of expert systems generators drives the growth of expert systems applications. Expert systems generators running on the IBM PC are already available and no doubt we will see more and less expensive varieties.

● The cost of specialized hardware for delivering turnkey systems will be coming down to a more reasonable level. In particular, price cutting should begin sometime after Texas Instruments introduces its Explorer system.

● In future, an important contributor to growth will be the availability of expert systems generators capable of generating run-time expert systems in languages other than LISP (e.g., FORTRAN, PL/I, C, ADA).

● A summary of the factors affecting growth in the expert systems applications sector is shown in Exhibit III-2.

2. RECOMMENDATIONS

● Vendors still face some important barriers.

- Users are confused by new jargon. Lengthy "AI primer" materials only add to the confusion. Instead, vendors should introduce products and services in data processing terms--e.g., "decision support," "data feedback loop controller," "parsing algorithm," and "program dictionary."

- Users are skeptical of the technology and require a lot of time to get warmed up. The education process is very slow. Vendors should give easily understandable demonstrations that potential clients can identify with.

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EXHIBIT III-2

GROWTH FACTORS AFFECTING
THE EXPERT SYSTEMS APPLICATIONS MARKET

- Generators Driving Applications Growth Because of:

  - Customization Needs

  - Lack of Clear Vertical Markets

- Prevalence of More Simplistic Systems That:

  - Have Restricted Domain Capacity (Vertical Market Generators)

  - Run on Microcomputer Systems

- Declining Hardware Costs

- Increasing Portability of Systems to Other Operating Environments, Driven by:

  - User Resistance to New Hardware

  - Vendor's Desire to Satisfy User Needs

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-       Maintenance of expert systems is a serious concern for users. As an
example of the costs associated with industrial expert systems mainte-
nance, Digital Equipment Corporation has established a formal training
program for knowledge engineers and has a highly skilled in-house
maintenance group to support their XCON and XSEL expert systems.
Maintenance costs minimize the marginal gain of investing in expert
systems applications and may make some applications uneconomical.

•   To overcome these obstacles, vendors should do the following:

-       Identify metaphors for AI terminology from well-known data processing
and operations research glossaries. In order to communicate effec-
tively, vendors need to explain to users--in their own language--the
usefulness of AI.

-       Reduce per-unit sales calls by holding seminars. Many vendors of
expert systems applications have experienced high per-unit sales
costs. This is because the first few hours of communicating with
potential clients usually involves explaining what AI is. It is better,
therefore, to have low-cost introductory seminars to serve this
purpose. Then, vendors can recruit potential clients from the semi-
nars. With the proper questions on a seminar registration form, pros-
pects can then be further qualified as to their ability to purchase.

-       Institute a development methodology that produces modular systems.
This will reduce maintenance costs later. Many expert systems are
designed with "the model" as their foundation. Unfortunately, "the
model" is not as static as some experts would like us to believe. When
it comes down to practice (versus theory), the organization of ideas
relies on real data (quantification) and on facts (qualification). These
data and facts should be organized along "model-independent" lines.

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- Recruit major users into product development. Fortune 500 users lack the technical expertise needed to develop expert systems in-house. Vendors who have this expertise lack the experience in developing business applications. Through joint product development, vendors can gain the experience they need to deliver expert systems applications to users.

B.   EXPERT SYSTEMS GENERATORS

1.   FORECAST AND TRENDS

- The fastest growing sector of AI is in the marketing of expert system generators. Expert systems generators and AI programming languages (i.e., LISP and PROLOG) will grow at an average annual rate of 63% to reach $230 million by 1990. This high growth is largely a result of a small starting base for this sector. User expenditures for 1985 are expected to be only $20 million (refer back to Exhibit III-1).

  - Vendors of expert systems generators have released their first products in the past eighteen months. Initial sales have been sluggish but should pick up as vendors begin to build up their marketing organizations and learn which vertical markets are best to target. Claims of 100% increases in sales and marketing staff were not uncommon among the vendors surveyed.

  - Artificial intelligence has had its mainstay in the aerospace- and defense-related industries. The market for expert systems generators will initially find its strength in these industries. In addition, insurance and large manufacturing companies were mentioned by respondents to show a significant interest in expert systems generators.

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- Except for stock brokerage firms, the banking and finance industry is a hard sell for 1985. "They tend to be caught up in deregulation," commented one observer. However, this vertical market is expected to take off late in 1986 or 1987 with industry-specific generators. These trends are captured in INPUT's growth rate forecast shown in Exhibit III-3.

- Vendors of expert systems generators will face many obstacles during the next twelve months. The support of systems analysts prepared to put expert systems generators to immediately productive use are concentrated in the aerospace- and defense-related industries. The remainder are spread out among many different vertical markets.

  - Once the penetration of these initial markets is achieved, vendors will be left with prospective clients who know little or nothing about expert systems.

  - As a result, they will be forced either to overcome the "knowledge engineer" requirement or to be strapped to long sales cycles and extensive training or customer support.

- The LISP and PROLOG programming languages have been available on microcomputers for some time. Although microcomputers do not offer the processing power needed to run sophisticated expert systems, they do allow for inexpensive prototyping.

- Both IBM and DEC have announced versions of LISP to run on their systems. Products offered are:

  - LISP/VM and (Paris Scientific Center) PSC PROLOG by IBM.

  - VAX LISP by DEC.

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EXHIBIT III-3

ARTIFICIAL INTELLIGENCE MARKET GROWTH RATE
BY APPLICATION, 1985-1990

Natural Language Systems

Expert Systems Generators

Expert Systems Applications

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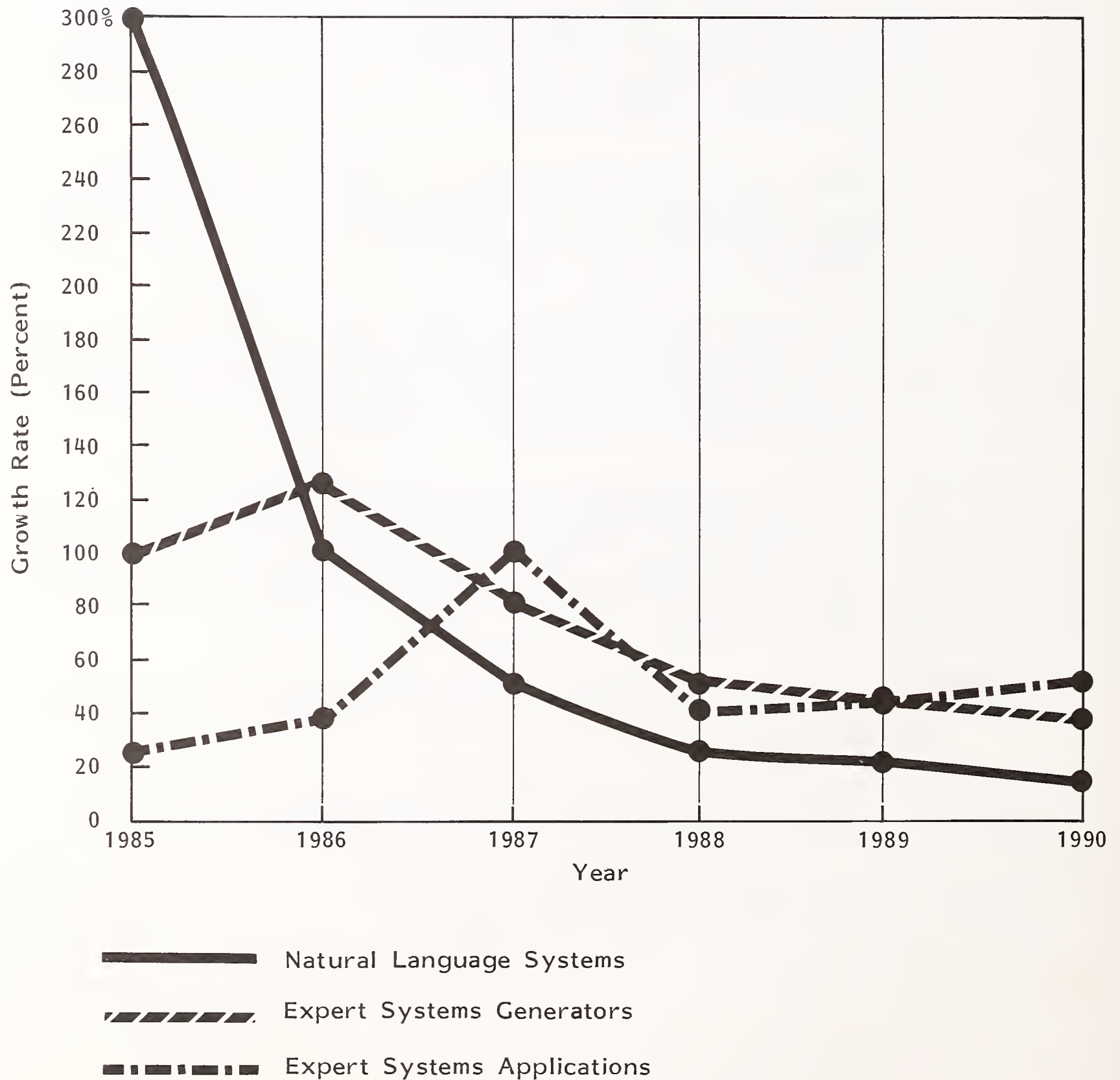
- DEC's VAX LISP is based on Common LISP, while IBM's LISP/VM was developed internally and employs the functionality of MacLisp and InterLisp.

2. RECOMMENDATIONS

- Portability precedes penetration. To Fortune 500 users, it is more desirable for the generators to run on the hardware they already have because the persons who know this hardware are already there. In addition, most expert systems applications that users will be developing with these tools require access to the corporate data base. Therefore, vendors should provide portability.

    - Vendors should provide software that runs on more than just LISP machines. Users want to make run-time expert systems that can be accessed from more than one end-user location.

    - LISP has not been formalized, and it does not appear that it will be soon. DEC uses Common LISP running under VMS, but even this "standard" varies slightly among vendors.

- In the same vein, vendors should improve the data base management capabilities of generators. Data base management systems vendors should take a good look at expert systems generators.

    - In addition, improvements in the user interface, though sometimes counter-efficient to processing speed, can greatly enhance the end user's image of an expert system generator.

    - And it is the end user, not IS, who perceives the value of expert systems.

- At present, many conceptual frameworks for managing information exist in library science, computer science, and cognitive science. However, con-

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ceptual frameworks that mirror the way people do business are needed in expert systems development.

- Vendors are urged to make an effort to improve education among potential buyers by maintaining contact with them through a short newsletter about AI. Don't rely on the press to keep AI alive. The more you can generate positive contact, the more likely it is that these prospects will become clients.

- The sizzle of expert systems generators is in the organization of personalized information. This suggests a great revenue opportunity for personal computer software vendors. Lower prices on PC-based expert systems generators will make them more acceptable to the individual buyer.

- The high cost of expert systems generators are difficult to justify to the AI-ignorant user. Providing low-cost entry-level generators allows users hands-on exposure to the power of expert systems, without risking a costly investment in hardware and software.

    - Microcomputer versions with reduced functionality are ideally suited for such entry-level generators.

    - Vendors that do not have entry-level PC-based products should develop such a product to help increase visibility. Most users are not convinced that the expert systems technology is for them.

    - Offering such a product lets the potential client play around with the technology before committing a large amount of funds to a full system.

- To successfully market applications development tools, the vendor needs to demonstrate that:

    - There is a need for expert systems in the client's company.

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- Their product will make it economically feasible for their client's information systems staff to develop these systems.

- The systems developed will be operational and maintainable by the in-house staff.

C.   NATURAL LANGUAGE SYSTEMS

- Natural language systems (NLSs) are really a part of the same generation as a fourth-generation language. The difference lies in more flexibility for the end user who deals with ad hoc report generation.

    - However, there may be a trade-off for the end user in time spent running an NLS. Most NLSs require that users teach the system their unique vocabulary in making requests.

    - This may sometimes take longer than teaching the user the command syntax of an English-like query language. But, for infrequent uses, NLSs may pay off in the long run.

- NLS applications have been limited in use to data base query, report generation, and telex interpretation.

1.   FORECAST AND TRENDS

- The market for NLSs is expected to grow at an average annual rate of 38%, from a base of $40 million in 1985 to a sound $200 million by 1990. (Refer back to Exhibit III-I.)

    - This growth is partially the result of IBM's endorsement of INTELLECT, an NLS by Artificial Intelligence Corporation. But other

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vendors are beginning to appear in the microcomputer arena and are offering innovative applications of NLSs.

- Access to corporate data bases for end users is a key issue facing users today, and NLSs will find their place in local data bases. Although a thorough analysis is beyond the scope of this report, the changing focus from centralized data processing to distributed data processing will be partially driven by the following:

  - The recent growth of computer-aided-design turnkey systems and personal-computer-based decision support processing has moved the focus of processing away from the centralized processor.

  - This trend will continue as PC-armed end users continue to gain control over their computing needs.

- Further discussion on the topic of distributed processing trends can be found in INPUT's Information Systems Program "micro-to-mainframe" report series.

- Relational data base management system (DBMS) users find NLSs cumbersome because they are usually well versed in the DBMS's query language.

- Besides data base query and report generation, natural language processors are beginning to be put to more creative uses.

- Right now, however, NLSs are an interesting alternative to English-like structured query languages. Their application will be limited by the level of priority that IS assigns to their installation.

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INPUT

2. RECOMMENDATIONS

- Data base management systems vendors should integrate NLSs into their products to aid end-user data access. Many such vendors have already incorporated INTELLECT into their products. For instance, ADABAS and FOCUS have natural language systems.

- Remote computing services vendors will benefit from such an integration and should incorporate NLS interfaces for all their products, since it is the end users they serve best.

- Microcomputer data base management systems vendors should closely watch Clout (an NLS interface by Microrim for its Rbase 4000 product) and should consider adding an NLS to their products.

INPUT

IV   VENDOR ACTIVITIES AND ANALYSIS

A.   INTRODUCTION

- The market for artificial intelligence is dominated by government contractors who have received contracts from the federal government for command and control applications under the DoD. These vendors have relied upon traditional programming languages (like FORTRAN and ADA) for systems development rather than using generators.

- Start-up companies in the artificial intelligence market began to emerge with frequency in 1980. Many of these vendors are hoping for a wave of demand to make them profitable in 1985.

- During the past four years, well-established vendors in the information services industry have entered the AI mainstream with new products and services.

B.   EXPERT SYSTEMS APPLICATIONS

- The majority of expert systems application vendors are professional services firms that have kept abreast of the technology and are positioned to control the strategic supply of skilled labor in knowledge engineering.

INPUT

- These vendors have chosen to concentrate on system development activities in order to acquire a wide range of experience in knowledge engineering. The most recent of these hope to utilize the new development tools to aid productivity in their product development activities. These vendors have yet to release any products, but they have been busy doing custom work and soliciting venture capital.

- Some vendors, particularly those offering expert systems generators (e.g., Teknowledge, Inference, IntelliCorp), have been developing expert systems to better understand the needs of potential clients to whom they hope to sell their generator packages.

- Today, very few expert systems applications are operational. Those that are are either proprietary or not portable, for technical and sometimes economic reasons.

- Expert systems software vendors have supplemented their product development efforts with custom development contracts from government and industry.

    - Because expert systems do not lend themselves to easy portability, very few systems have been developed that can be sold as an application package.

    - However, despite this (and also despite the long development cycle), many vendors expect to release products this year and to continue the development of existing products to make them more portable.

- Smart Systems Technology (McLean, VA) and Battelle Memorial Institute (Columbus, OH) are particularly strong in their experience with government request-for-proposal (RFP) procedures and expert systems development.

INPUT

- Smart Systems Technology (SST) has focused on consulting and systems development in AI since 1982. Some of the clients for which SST has completed work (or with whom SST is currently working) are:

  - General Dynamics Corp. (San Diego, CA).

  - Shell Development Corp. (Houston, TX).

  - International Monetary Fund (Washington, DC).

  - U.S. Army Engineer Topographic Labs.

- An expert system (ARBY) for fault diagnosis in avionics test equipment was developed for General Dynamics and has subsequently been modified and licensed to ITT and Boeing Corporation in the context of expert systems development by SST professionals. In addition, ARBY is being leased by Shell Development Corporation.

- Battelle Memorial Institute (BMI) has been developing custom expert systems mostly for DoD and has done some work for one manufacturer. The company has indicated that it will be shifting its emphasis this year from custom work to licensing products and has expressed an interest in the banking and finance industry.

- Brattle Research Corporation (Cambridge, MA) has developed an information management system that allows users to access multiple data bases on the Dow Jones News Retrieval Service and then customize their own knowledge base. The company expects to deliver a similar product for other companies soon.

- Some vendors hope to deliver turnkey systems on specialized machines as workstations for those in the banking and finance and insurance industries. Two of the leading vendors that are directing their efforts toward these industry segments are Syntelligence and Applied Expert Systems (APEX).

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- Syntelligence (Palo Alto, CA) is working with a leading property and casualty insurance company to develop an underwriting advisory system to assist underwriters in assessing the risks associated with a particular line of business.

  - Once the system is developed, the company expects to sell additional units to other leading institutions.

  - A leading advisor for banks is also currently under development.

- APEX (Cambridge, MA) has indicated that it is working with a financial institution developing a turnkey system for Xerox 1100 series computers. The type of financial institution that APEX is working with is undisclosed; APEX is very secretive about its operations. However, APEX claims to be marketing to insurance, banking, brokerage, and accounting firms. APEX has 50 employees now and considers Syntelligence to be its most formidable contender.

- There is no doubt that similar vendors have an eye on the financial community and are watching these two companies very closely. INPUT has knowledge of at least one major information services vendor developing an advisory system for a brokerage firm.

- Teknowledge Inc. (Palo Alto, CA) is working on a knowledge-based expert diagnostics system for General Motors that will assist automotive mechanics in the diagnosis of automobile engine component malfunctions. Teknowledge will also be contributing to FMC's defense contract bidding efforts. General Motors and FMC each own an 11% share in Teknowledge. (See the company profile in Chapter V.)

- The main expert systems application vendors, by application area, are shown in Exhibit IV-1.

INPUT

EXHIBIT IV-1

SELECTED EXPERT SYSTEMS APPLICATION VENDORS
BY MAJOR APPLICATION AREA

VENDOR	BANKING AND FINANCE	INSURANCE	MANU-FACTURING	AEROSPACE AND DEFENSE	DATA BASE RETRIEVAL
Smart Systems Technology	PS		PS	PS	
Battelle Memorial Institute	TKY, SW			PS	
Inference			PS, SW	PS	
IntelliCorp				PS	
Teknowledge			PS	PS	
Syntelligence	TKY, PS	PS			
Applied Expert Systems	TKY, PS	PS			
Brattle Research Corporation					PS

PS = Professional Services

TKY = Turnkey Systems

SW = Software

INPUT
MSAI

- Vendors currently competing in the expert systems applications market are there for different reasons.

    - Vendors positioning themselves in expert systems generators are there because they wish to understand the problems of their future software tool clients. These vendors will find that they have a lot of educating to do and will, out of necessity, be doing more custom work or will have a very busy support staff.

    - Vendors positioning themselves in custom development are trying to gain industry expertise that they can flaunt to a potentially large client base (from manufacturing and finance industry segments). These clients will seek vendors whose knowledge engineers are competent and well informed. These vendors are well positioned for attacking a vertical-market niche, provided they develop maintenance teams within the contracted organizations.

    - The vendors selling turnkey systems, like APEX and Syntelligence, are hoping that they will gain enough function-specific custom contracts so they can sell their units as workstations. These vendors are well aware that selling expert systems as turnkey systems requires a lot of time with the customer. Unfortunately, this will be true so for quite a while.

- The most immediate problem facing the start-up expert systems applications vendors is earning a profit. Generally, these vendors have been supported by large development contracts or venture capital. Or in some cases (e.g., Teknowledge), the vendor has opted to sell equity shares to major clients in order to secure future revenue streams.

- In order for user organizations to perceive the value of an expert system, they must first have an understanding of the technology to appreciate it. Initial

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sales (as discussed in Chapter III) are going to companies that have already experimented with AI and that recognize its value. Offering multimedia training seminars is one way to communicate this knowledge to companies that have not experimented with AI.

- Sales support and maintenance presents another problem. Since this is critical for repeat purchases, INPUT recommends extending training seminars that deal with maintenance issues and that build user-site support teams.

- Finally, defining the vertical-market sectors for which expert systems applications are most appropriate is important for streamlining vendor marketing efforts. It is helpful to identify different levels of receptivity that prospects can be qualified by. The following questions should be considered:

    - Does the prospect have an AI or OR group already in place?

    - How many people are in this group?

    - Is the client able to identify applications suitable for expert systems within the company?

- A summary of these problems and INPUT's recommended solutions is given in Exhibit IV-2.

C. EXPERT SYSTEMS GENERATORS

- Many vendors of expert systems generators began as spinoffs from academic research projects for early expert systems or as extensions of custom software development contracts for defense and aerospace firms.

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EXHIBIT IV-2

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PROBLEMS FACING EXPERT SYSTEMS APPLICATION VENDORS

PROBLEM	RECOMMENDATION
• Becoming Profitable in Order to Stay Afloat During the Long Development Cycle	• Negotiate Equity with Major Clients
• Educating the Client	• Provide Multimedia Training Seminars
• Providing a Solution to Systems Maintenance	• Extend Training Seminars to Post-Project Support Team Development
• Defining the Vertical Market Sector to Which Applications Are Appropriate	• Identify Levels of Receptivity by Which Prospects Can Be Qualified

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MSAI

- These vendors have taken a variety of approaches to the problem of simplifying the expert system development process. The tools available for expert systems development can be differentiated by the approach each uses in the development of the expert system. Some tools (e.g., S.I, KEE, ART) are targeted toward applications programmers, while others (e.g., TIMM, Expert Ease) can be utilized by end users for prototyping or design, depending on the domain of the knowledge.

- Vendors that provide this latter type, referred to here as "example-driven" systems, are Human Edge Software (HES) and Flow General Corporation (FGC).

- Human Edge Software (Palo Alto, CA) markets a product called Expert Ease, developed by Expert Ease Ltd.

    - Initial marketing efforts for the product in the U.S. began with another independent firm, located in San Francisco. But these efforts failed, and HES was given exclusive marketing rights in the U.S.

    - Expert Ease works somewhat like a spreadsheet. The end user defines the various inputs (called "attributes") and the decision associated with different combinations of attributes. The end user then enters sample combinations of attributes and the decision that he or she, as an expert, would conclude.

- Flow General Corporation's (McLean, VA) product, The Intelligent Machine Model (TIMM), was written in FORTRAN and runs under VMS on the DEC VAX. There is also a PC-DOS version for users with 640K of RAM on the IBM PC.

    - The end-user interface for expert systems development on TIMM is very similar to that of Expert Ease, except that it doesn't appear like a spreadsheet.

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INPUT

- In addition, the user can assign probabilities to multiple decisions given the same attributes.

- Another way of viewing expert systems generator vendors is according to the hardware systems on which they run. Most expert systems generator vendors offer products that run on specialized hardware like the Xerox 1100 series or Symbolics 3600 computers. The 32-bit architecture and high-resolution graphic displays these machines have offer the preferred environment for developing expert systems. (IntelliCorp, Texas Instruments, and Teknowledge are three vendors whose systems run on such specialized hardware. See the company profile in Chapter V.)

  - However, the sale of this type of generator will always require the sale of the hardware workstation along with it. This increases the entry-level price of expert systems generators.

  - Also, very few links of these workstations to mainframes or minicomputers have been available to date.

- Some vendors offer generators that run under VM or VMS. These generators are usually written in a conventional language such as FORTRAN and are thus portable to a larger group of hardware systems. Examples of such products are Reveal (from McDonnell Douglas Knowledge Engineering) and TIMM (from FGC).

  - McDonnell Douglas Knowledge Engineering (Cupertino, CA) markets Reveal to decision support applications programmers and operations research professionals who want the capability to develop expert systems combined with complete decision support capabilities.

  - Reveal runs under VM, VMS, PRIMOS, and PCDOS. MVS and UNIX versions will be available later in 1985.

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- Vendors of expert systems generated and the hardware their products run on are shown in Exhibit IV-3.

- INPUT believes that the successful commercialization of expert systems generators depends on:

  - Portability of expert systems developed with these tools.

  - Maintainability--by in-house staff--of expert systems developed with these tools.

  - Flexibility of expert systems design with these tools.

- LISP-based systems running on a specialized machine offer much flexibility. However, maintenance is a serious problem, because very few applications programmers (potential knowledge engineers) are proficient in LISP. This is true at least in relation to the number of applications programmers proficient in FORTRAN.

- The emerging market for expert systems application development tools is in a state of flux. There are almost as many variations in products as there are vendors. And each of these vendors are struggling to find markets for their existing products.

- Maintenance of complex expert systems is a deterrent to cultivating mass appeal of expert systems among information systems groups in user organizations. However, there are great possibilities for simpler, example-driven systems.

  - TIMM's micro version is a good candidate for success.

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EXHIBIT IV-3

SELECTED EXPERT SYSTEMS GENERATOR VENDORS

VENDOR	PRODUCT	HARDWARE	PRICE
Human Edge Software	Expert Ease	IBM PC, DEC Rainbow, Victor Technologies 9000	$125 $2,000
Teknowledge	M.1 S.1	IBM PC Xerox 1100 and 1108 and DEC VAX	$12,500 $50,000 - $80,000
IntelliCorp	Knowledge Engineering Environment (KEE)	Symbolics 3600 Xerox 1100 Xerox 1108	$60,000
Texas Instruments	Personal Consultant	TI Professional Computer	$3,000
Inference Corp.	Advanced Reasoning Tool	Symbolics 3600 LISP Machine DEC VAX	$48,000 - $60,000
Silogic	Knowledge Workbench	Masscomp, Plexus, Sun, Sumitumo Electric	$6,900 - $20,000
McDonnell Douglas Knowledge Engineering	Reveal	Prime, IBM PC, IBM Mainframes (VM) DEC VAX	$4,500 - $70,000
Flow General	"TIMM" The Intelligent Machine Model	IBM XT/AT; DEC VAX	$9,500 $39,500

INPUT
MSAI

- Expert Ease is too limited to be very useful, but the company is working to improve the program.

- In either of these two cases, marketing acumen will determine the winner.

- A problem with micro products is the obvious power and memory restrictions. However, some applications may be suitable for micros as they gain greater memory capacity and processing speed.

  - A good product for this market would be a TIMM-like product that runs under MVS/XA and interfaces with a relational data base management system and a fourth-generation language.

  - Unfortunately, TIMM runs only under VMS, and no conversion utility is in sight.

D.   NATURAL LANGUAGE SYSTEMS

- Natural language systems (NLS) are being used for data base query, report generation, and telex interpretation.

- Substitute products for Artificial Intelligence Corporation's INTELLECT are beginning to emerge, and the competition is stiffening.

- Natural language systems for data base query is dominated by Artificial Intelligence Corporation (AIC).

- Artificial Intelligence Corporation (Waltham, MA) introduced the first NLS in 1981 and has since established installations in more than 260 locations across the U.S. (See the company profile in Chapter V.)

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- In addition, AIC has a well-established user base of some 200 client companies because of its early introduction and fast acceptance by processing services vendors that saw the potential for product differentiation for their data base and reporting products.

- Now, IBM supports the product for use with its VSAM file structures and Structured Query Language.

- INPUT estimates that AIC has 40% of the 1984 NLS market.

- Another vendor, Cognitive Systems Inc. (New Haven, CT) is pursuing new avenues in NLS applications. (See the company profile in Chapter V.)

    - Cognitive Systems Inc. (CSI) is in the process of working out a joint marketing agreement with a Belgian bank for which they developed an NLS interface to the bank's customer investment advisory system.

    - CSI is also working with Dialog Information Systems (New York) on a decision support system with an NLS for accessing the Nielsen data bases.

    - CSI has been working on a system for the Coast Guard that reads telexes announcing the location and sail plan of ships. The system processes the unformatted telexes and updates the Coast Guard's AMVER data base.

- On the micro side, the development of NLSs as interfaces to micro-based data base management systems is currently being explored by Microrim.

- In 1984, Microrim (Bellvue, WA) released Clout, an NLS for its Rbase 4000 relational data base management system running on the IBM PC. Clout has remained on the Softsel Hotlist for 26 weeks and may very well prove to be a good way to differentiate a micro product.

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INPUT

- Another avenue being explored is applying NLSs to a turnkey financial system by Intelligent Business Systems (IBS). IBS (New Haven, CT) has integrated an NLS product developed for them by CSI--EASYTALK--with the accounting series of Amcor Computer Corporation (Louisville, KY) into a turnkey system on a VAX 11/730. (See the company profile in Chapter V.)

- Vendors of data base management systems, on-line data bases, and integrated applications packages should look at these NLS products as a means for differentiating their products. Examples of vendors that have done this include:

    - Cullinet Software which markets On-Line English (INTELLECT) as an interface to its IDMS data base management system.

    - Information Sciences, which markets GRS Exec as an interface to its Human Resource System.

    - Honeywell, which markets INTELLECT as a user interface to its MRDS data base management system.

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V   VENDOR PROFILES

- This section presents vendor profiles on companies that are very active in the artificial intelligence services markets. Most are small (from a revenue standpoint), but they are important for the technologies they are developing or for the market niches they are targeting.

- For the sake of completeness the descriptions that follow cover all of the vendors' information services activities. The vendors included are:

    - Artificial Intelligence Corporation.

    - Cognitive Systems, Inc.

    - IntelliCorp.

    - Intelligent Business Systems Inc.

    - Teknowledge Inc.

INPUT

ARTIFICIAL INTELLIGENCE
  CORPORATION
100 Fifth Avenue
Waltham, MA 02254
(617) 890-8400

Larry R. Harris, President
Private Corporation
Total Employees: 60
Total Revenue, Fiscal Year End
  3/31/84: $4,000,000*

THE COMPANY

- Artificial Intelligence Corporation (AIC) was founded in 1975 by Larry Harris to develop INTELLECT, the first natural language English query system available commercially. INTELLECT, in research and development until its introduction in early 1981, is now installed at over 260 locations across the U.S.

- T. A. Associates, a Boston-based investment firm, invested an estimated $1.8 million in AIC in October 1980, a short time before the introduction of INTELLECT. In June 1984 a private offering gained an additional $5 million investment.

- As of fiscal year end March 1984 AIC had 60 employees. AIC currently has 54 employees segmented as follows:

Marketing/sales	13
Software services/ customer support	17
Research and development	15
General and administrative	9
	54

- While AIC is by far the leading vendor of natural language query systems, some competitors have emerged in this sector of the artificial intelligence market. These include Cognitive Systems, Inc. in New Haven (CT), Bolt Beranek and Newman in Cambridge (MA), and MICRORIM in Bellevue (WA).

KEY PRODUCTS AND SERVICES

- AIC derived 100% of its fiscal 1983 revenue from software product and related services. Approximately 10% of revenue was from fees for customer application-specific dictionary development.

- INTELLECT is the first commercial on-line natural language query system employing artificial intelligence technology to allow nontechnical users to interact with computerized data bases using everyday, conversational English. The system performs information retrieval, display, and analysis,

*INPUT estimate

INPUT

placing the burden of understanding and clarification on the computer, not the user.   Because it is unnecessary to learn rigid grammatical codes, query languages, or special syntax, almost no training is required to use the system.

- Features include the following:

    . A built-in ability to analyze English grammar and understand a wide variety of query forms, including complex sentences, pronoun references, sentence fragments, poor syntax, and ambiguities.

    . An understanding of each user's particular vocabulary and linguistic style through use of a customized Lexicon, or dictionary.

    . An almost instant translation of queries, which optimizes data retrieval and ensures quick response.

    . Response to user queries in clear, familiar English, phrased in terms of the query.

    . An ability to relate information from several files to respond to a query.   The system uses contextual interpretation to discern intended meanings.

    . A library of data processing functions including statistics (minimum, maximum, average, and total); counting; correlation; comparison; totalling and subtotalling; total ratio; ranked comparison, subtotals, and percent-of-total; and histogram with vertical and horizontal display and report output formats.

    . Color graphics display through a dynamic interface to IBM's PGF graphics system.

    . General file-level, record-level, and field-level security invoked by a password.

- INTELLECT can be applied to any application. The majority of applications are business-oriented, including payroll, personnel, human resources, marketing, financial, and banking.

● The Lexicon, a key element in the INTELLECT system, is an application-specific dictionary custom designed for each respective business environment to reflect vocabulary, special terminology, synonyms, and user jargon. It contains value names and descriptions of each file, record, and field that may be called for in a query, allowing INTELLECT to understand inquiries phrased in a wide variety of ways.

- The Lexicon directs INTELLECT to perform computations on specific data fields for use in display, printout, record selection, and sorting and to translate data codes into terms more familiar to the user.

- INTELLECT uses the Lexicon to define logical, complex, and multilevel relationships within the data for use in interpreting queries.

- Lexicon entries control operational aspects including size and format of the terminal display screen and printed page, security and user-selectable viewing instructions, sorting of data, and default responses to nonspecific queries. A master interaction file logs unfamiliar words for use in updating the Lexicon.

- AIC customer support representatives are trained to construct, add to, and maintain Lexicons and train users to perform these same tasks. Lexicon development requires one to six weeks.

- Versions of INTELLECT are currently available for use with AIC's DFAM (Derived File Access Method), Software AG's ADABAS, Information Builder's FOCUS, and IBM's VSAM and SQL. INTELLECT also interfaces to IBM's Presentation Graphics Facility (PGF).

  - INTELLECT is available through OEM vendors under various product names.

    - Cullinet Software markets On-Line English, which interfaces with its IDMS data base management system.

    - Information Science markets GRS Exec as an interface to its Human Resource System.

    - Integral Systems markets IQ200 Report Writer which serves as a module to their Human Resource Management System.

    - Management Decision Systems markets ELI (English Language Interface) as an interface to Express, its modeling analysis system.

    - Honeywell markets INTELLECT under the MULTICS operating system with an interface to its MRDS data base management system.

  - Plans include the development of INTELLECT interfaces to various data base management systems and graphics, statistical, and modeling packages.

- Intellect's Micro-to-Mainframe Link product will integrate IBM PC applications into terminal emulation on the personal computer. The software, which requires a mainframe connection, acts as a front-end supervisor to many database, graphics, and spreadsheet programs. Micro-to-Mainframe Link will be available in the third quarter of 1985.

- INTELLECT is available on the processing networks of Boeing Computer Services, Control Data Corporation, Decision Products Services, and AVCO Computer Services.

INPUT

- AIC clients are primarily Fortune 500 companies and include Ford Motor Company, which uses INTELLECT to check environmental standards for its automobiles; Du Pont, where over 100 employees use INTELLECT to handle questions about sales and production of plastics, polymers, and resins; and Fleet Financial Group, where INTELLECT is used for commercial loan portfolio applications.

    - Other clients include Aetna Life & Casualty, Long Island Lighting, Reynolds Metals, Southern California Edison, Steelcase, and Chemical Bank.

- INTELLECT runs on IBM 370, 4300, 30XX, and compatible mainframes under OS, DOS, VS, VM/CMS, and Honeywell's MULTICS. A limited version will operate on any Prime minicomputer running under PRIMOS. Versions are being developed for use in other minicomputer environments.

    - The INTELLECT package is priced at $69,500, which includes training and support. Interfaces and Lexicon development are additional.

    - There are over 260 installations of the product, which has been commercially available since early 1981.

- AIC plans include the eventual use of INTELLECT as the common query language and interface between all data bases and software systems in a company's data center, acting as the only system required for the end user to interact with.

INDUSTRY MARKETS

- AIC's fiscal 1984 revenue was derived from the following industry segments:

Discrete manufacturing	13%
Transportation	2
Utilities	8
Banking and finance	10
Insurance	17
Medical	2
Services	10
Other	38
	100%

GEOGRAPHIC MARKETS

- One hundred percent of fiscal 1983 revenue was derived from the U.S.

    - AIC maintains sales branch offices in New York, Los Angeles, San Francisco, Washington (DC), and Houston.

INPUT

COMPUTER HARDWARE AND SOFTWARE

- AIC has one IPL 4446 running under VM and various IBM PCs and terminals installed in Waltham.

INPUT

COGNITIVE SYSTEMS, INC.
234 Church Street
New Haven, CT 06510
(203) 773-0726

Dr. David Fox, President
Private Corporation
Total Employees: 23
Total Revenue, Fiscal Year End
    11/30/84: $1,000,000*

THE COMPANY

- Cognitive Systems Inc. was founded in 1979 by Dr. Roger Schank to develop expert systems capable of understanding natural language input. The company currently develops custom expert systems, natural language end-user inter- faces, and natural language telex interfaces. In addition, the company sells T, an artificial intelligence programming language (a dialect of LISP). Dr. Schank holds positions at Yale as the Chairman of the Computer Science Department and the Director of the Artificial Intelligence Lab.

- In March 1984 Cognitive obtained $2.8 million of investment capital from a private placement offering. The funds were used for working capital, product development, and equipment acquisition.

- Cognitive's 23 employees are segmented as follows:

Marketing/sales	3
Software services/customer support	1
Research and development	14
General and administrative	5
	23

- Cognitive competes in two distinct markets that have emerged from artificial intelligence research.

    - Natural language interfaces developed by Cognitive compete with Artificial Intelligence Corporation's Intellect installed base of more than 250 locations.

    - Cognitive competes with IntelliCorp and Bolt, Beranek and Newman for expert systems-related professional services.

KEY PRODUCTS AND SERVICES

- Cognitive's fiscal 1984 revenues were derived as follows:

Professional services	90%
System software	10
	100%

*INPUT estimate

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INPUT

- Cognitive specializes in building expert systems that:

    - Understand natural-language input.

    - Analyze a user's request and goals.

    - Offer information relevant to the knowledge domain of the expert system.

- Some definitions relating to artificial intelligence systems follow:

    - Expert systems (referred to synonomously as knowledge-based systems) are systems that contain specialized knowledge, both factual and heuristic, and that are able to reach conclusions by applying the specialized knowledge to problems presented by the user. Programming techniques used to develop these systems are the result of research in the academic field of artificial intelligence (AI).

    - Natural Language interfaces are knowledge-based systems that specialize in the grammatical and definitional rules of written languages, thereby allowing input in the form of grammatically correct sentences such as data base queries entered at an input device. The methods used to develop these interfaces for Cognitive came from Dr. Schank's research in AI at Yale University. Similar research was done by Dr. Larry Harris of Artificial Intelligence Corporation in Waltham (MA) from 1975 to 1981 and resulted in the creation of Intellect, a natural language interface currently being marketed by Artificial Intelligence Corporation.

- Cognitive has defined three types of systems that they develop: Natural Language Front-Ends, Conversational Advisory Systems, and Automatic Processing Systems.

    - Natural Language Front-Ends are natural language interfaces that the company fits to existing data bases for end-user queries. Examples of systems in this category that the company has developed include the following:

        . EXPLORER is an English language interface to a graphics package operating on a large oil well data base.

        . DESI (under development) is a decision support system with a natural language front-end used to access the SAMI and Nielsen data bases. DESI is being developed with Dialog Information Systems of New York. Up until the fall of 1984, the system was referred to as MARKETEER.

        . EASYTALK I is an English language interface bundled with a small business system that integrates 14 standard accounting packages. Cognitive completed development of EASYTALK I in

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INPUT

October 1983 for Intelligent Business Systems, Inc., who markets the system.

- BROKER is a demonstration natural language front-end to Standard & Poor's COMPUSTAT. BROKER is used only as a demonstration of a natural language interface for Cognitive and is not available commercially.

- Conversational Advisory Systems are expert systems with a natural language interface used to engage the user in a dialog and offer advice about a particular area within the knowledge domain of the expert system. These systems are more sophisticated than Natural Language Front-Ends in that they produce natural language output for the user about the expert system's knowledge domain. Example systems in this category which Cognitive has developed are listed here.

  - LE COURTIER is a decision support system that will be used by financial analysts of a major Belgian bank. One version of the system contains a set of rules used by the bank's analysts in advising customers on stock purchases and allows for each financial analyst to input his own personalized investment rules. In a second version of the system the bank's customer can modify the advice given by the system by stating personal preferences in conversational English. (Subsequent versions of the system will include French and Flemish.) A joint marketing arrangement is under negotiation with the bank to distribute the system throughout Europe.

  - TRANSLETTER (under development) is a multiple-language system that generates standard business letters and creates a personalized data base for each user. TRANSLETTER is expected to be ready for distribution in 1986.

- Automatic Processing Systems are data processing systems that use a natural language interface for handling machine-readable textual inputs such as telexes. Cognitive is nearing completion of a system for the Coast Guard that reads telexes announcing the location and sail plan of ships. The system processes the unformatted telexes and updates the Coast Guard's AMVER data base.

- Cognitive's system software sales are derived exclusively from software licenses for T, a dialect of LISP developed at Yale University. All of Cognitive's custom systems are written in T, which currently runs on Apollo computers and on the DEC VAX under both UNIX and VMS.

COGNITIVE SYSTEMS, INC.

INDUSTRY MARKETS

- Cognitive derived its fiscal 1984 revenue from the following industry sectors:

Banking and finance	45%
Wholesale distribution	30
Federal government	20
Other	5
	100%

GEOGRAPHIC MARKETS

- Cognitive's fiscal 1984 revenue was derived from the following geographic segments:

U.S.	60%
Europe	40
	100%

COMPUTER HARDWARE AND SOFTWARE

- The company currently has the following hardware installed for development purposes:

  - 1 Apollo 460, operating under AEGIS.
  - 2 Apollo 420s, operating under AEGIS.
  - 12 Apollo 300s, operating under AEGIS.
  - 3 DEC PDP 11/785s, operating under UNIX and VMS.

INPUT

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707 Laurel Street
Menlo Park, CA 94025
(415) 323-8300

Ralph Kromer, President
Public Company, OTC
Total Employees: 83
Total Revenue, Fiscal Year End
6/30/84: $2,075,866

THE COMPANY

- IntelliCorp markets expert systems software development tools, custom expert system development professional services, and applications software, turnkey systems, and remote computing services for genetic engineering (biotechnology). Expert systems (referred to synonomously as knowledge-based systems) contain specialized knowledge, both factual and heuristic, and are able to reach conclusions by applying the specialized knowledge to problems presented by the user. Programming techniques used to develop these systems are the result of research in the academic field of artificial intelligence (AI).

    - IntelliCorp was founded in September 1980 as IntelliGenetics, Inc. by four Stanford University scientists to develop and market software based on AI technology for genetic engineering applications. The founders were Edward Feigenbaum, Peter Freidland, Lawrence Kedes, and Douglas Brutlag. The company changed its name in June 1984 to reflect a shift to general-purpose AI products and formed a separate division called IntelliGenetics, Inc., to market its genetic engineering software.

    - In August 1981 IntelliCorp received $583,000 in venture capital funding. In March 1982 the company received an additional $1,402,000 in venture capital.

    - In November 1983 Computer Services Corporation (CSK), a Japanese software and computer services company, agreed to purchase 166,666 shares of preferred stock in IntelliCorp after receiving an exclusive license to distribute the company's expert systems software development product (KEE) in Japan. In January 1984 the Japanese government approved the licensing agreement and the preferred stock was converted automatically share for share to common stock. March 1984 average common shares outstanding are close to five million; as a result, CSK currently owns less than 3% of IntelliCorp.

- In December 1983 the company made an initial public offering of 1.6 million shares of common stock. IntelliCorp was the first artificial intelligence company to go public. Net proceeds of $8.5 million were used to finance

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INPUT

future product research and development, computer equipment acquisitions, leasehold improvements, and provide working capital.

● Fiscal 1984 revenue reached $2.1 million, a 255% increase over the previous fiscal year. Net losses also increased 131% from $730,000 in fiscal 1983 to $1.7 million in fiscal 1984. A four-year financial summary follows:

INTELLICORP
FOUR-YEAR FINANCIAL SUMMARY
($ thousands, except per share data)

ITEM / FISCAL YEAR	6/84	6/83	6/82	6/81(a)
Revenue	$ 2,076	$ 585	$ 131	-
. Percent increase from previous year	255%	345%	-	-
Income (loss) before taxes	$ (2,170)	$ (826)	$ (644)	$ (25)
. Percent increase from previous year	163%	28%	-	-
Net income (loss)	$ (1,684)	$ (730)	$ (545)	$ (25)
. Percent increase from previous year	131%	33%	2,069%	-
Earnings (loss) per share	$ (0.41)	$ (0.34)	$ (0.26)	$ (0.01)
. Percent increase from previous year	21%	31%	26%	-

(a) Includes operations of company from inception in September 1980 to June 30, 1981.

● IntelliCorp management attributes the growth in fiscal 1984 revenue primarily to increased product sales, principally BION workstations and KEE system licenses.

● Net losses reflect the following increased expenditures made during 1984:

- Research and development expenses reached approximately $1.3 million in fiscal 1984 (64% of revenue), as compared to $548,119 in fiscal 1983 (94% of revenue), and $231,220 in fiscal 1982 (176% of revenue). The major product development effort has been concentrated in the KEE system, genetic engineering and other applications software.

INPUT

- Marketing, general, and administrative expenses were approximately $1.8 million in fiscal 1984, as compared to $472,126 in fiscal 1983, and $415,685 in fiscal 1982. IntelliCorp significantly expanded its marketing and sales organization during 1984, increasing its need for additional general staff, marketing personnel, advertising, and larger facilities.

- IntelliCorp is currently organized into two operating divisions as follows:

    - The Knowledge Systems Division develops, markets, and supports expert systems software development tools and provides professional services for custom expert systems development.

    - The Biotechnology Division (which has also retained the name Intelli-Genetics, Inc.) provides applications software products, remote computing services, and a turnkey system for genetic engineering applications.

- As of June 1984 the company had 83 employees, a 388% increase over a total of 17 employees in June 1983. The company currently has approximately 94 employees.

    - The company currently has approximately 25 knowledge engineers for custom expert systems development.

- IntelliCorp has competitors in three distinct markets:

    - Competitors in the expert systems software development tools market (IntelliCorp's KEE product) include Teknowledge Inc., Inference Corporation, and The Carnegie Group.

    - Competition in the genetic engineering software market is present in the form of low cost access to similar systems at the University of Arizona, University of Minnesota, and Cornell University.

    - In the professional services market, IntelliCorp competes with Teknowledge, specifically in the design of custom knowledge-based expert systems.

INPUT

KEY PRODUCTS AND SERVICES

● IntelliCorp's fiscal 1984 revenue was derived approximately as follows:

	Percent of Total
Remote computing services	32%
Software products	26*
Turnkey systems	26*
Professional services	16
	100%

*INPUT estimate

● In 1983 IntelliCorp introduced the Knowledge Engineering Environment (KEE$^{T.M.}$), an integrated package of artificial intelligence software development tools that provides a programming environment for building knowledge-based systems for commercial and industrial applications.

- With the KEE System, a trained user can work with an expert in organizing factual, experimental, and judgmental knowledge in the expert's field of application and can build a computer software system that represents that knowledge. The resulting knowledge-based system can draw inferences, interpret knowledge, test premises, reach conclusions, display the chain of reasoning and otherwise perform or support expert decision-making and problem-solving functions in the chosen application area.

- KEE is currently available for use on the following LISP machines: the Xerox 1108 workstation, the Symbolics 3600 family of computers, and the LISP Machine, Inc. Lambda workstations.

- In August 1984 IntelliCorp announced release 2.0 of the KEE system, with availability scheduled for early 1985. This release adds a new query language, enhanced graphics capabilities, a more powerful reasoning system, and extended knowledge representation features, and will be provided to existing customers as a program update.

- The company charges $60,000 for a nontransferable license of KEE, which includes training and support services. The system can be purchased without training and support for $30,000.

- During fiscal 1984, KEE systems were delivered principally to large corporate customers and government laboratories. Applications by these customers include: design of process control strategies for metals manufacturing, quality assurance analysis in aerospace, diagnosis of machine failure in building environmental systems, communications software planning, and design of special purpose scientific instruments.

INPUT

- Among IntelliCorp's KEE customers is Ford Aerospace & Communications Corporation and a major public utilities company.

- In August 1984 IntelliCorp entered into a joint marketing agreement with Symbolics, Inc. to market KEE. In November 1984 IntelliCorp also announced it had reached an agreement in principle with Sperry Corporation to market the KEE product.

- Professional services offered by IntelliCorp include education and training services related to software sales and custom expert systems development.

  - IntelliCorp engages, on a contract basis, in the development of knowledge-based systems for clients who desire direct involvement of IntelliCorp's knowledge engineers during implementation of systems using the KEE software. Services may include problem evaluation, prototype development and final system implementation.

  - The company is currently helping a major public utilities company develop end-user products for the marketplace.

- IntelliCorp's first product, introduced in 1982, is an integrated package of biotechnology scientific applications programs specifically developed for recombinant DNA research. There are currently over 600 scientists using this software, which is available via timesharing, as a licensed software product for in-house use, and as part of a turnkey system.

  - The software provides assistance to scientists in planning and managing cloning experiments and in nucleic acid, protein and DNA sequence analysis, comparison, and manipulation. Several of the programs access large data bases developed by NIH and the National Biomedical Research Foundation in the U.S. and the European Molecular Biology Laboratory.

  - The biotechnology software series, however delivered, contains the following nine modules which are not sold separately:

    - CLONER - Construction of restriction maps from enzymatic digests.
    - SEQ - Nucleic acid sequence analysis, comparison, and manipulation.
    - PEP - Amino acid sequence analysis, comparison, and manipulation.
    - QUEST - biological data base management.
    - MAP - Determination of restriction maps from enzymatic digests.
    - GEL - Management of large-scale DNA sequencing projects.
    - SIZER - DNA fragmented length calculation.
    - GENED - Simplified entry of nucleic acid and amino acid sequence data.
    - IFIND - Comparison and alignment of biosequences.

- The company has more than 75 processing services customers accessing nine biotechnology software modules running on a DEC 2060 located at the company's headquarters in Menlo Park (CA). Infogen, a commercial vendor located in Paris, has the only remarketable installation of the biotechnology software. All other installations of the software outside of the company's installation are nontransferable perpetual software license agreements.

- Software licenses to customers who wish to operate the system in-house cost $43,000 each and run under VMS on the DEC VAX 11/730, under TOPS20 on the DEC 2060, or under UNIX on Sun Microsystems' system. A 15% discount is given to academic or nonprofit organizations and a 15% premium is charged for purchases outside of the U.S.

- IntelliCorp's turnkey system product, the BION[T.M.] Workstation, comes with all nine of the biotechnology software modules on a Sun Microsystems computer operating under UNIX. In December 1984 the company started to unbundle the software from the system. The BION workstation was first introduced in 1983.

- In March 1984 IntelliCorp was awarded a five-year, $5.6 million contract by the National Institute of Health (NIH) to run BIONET, a national computer resource for research in molecular genetics.

  - The BIONET resource includes IntelliCorp's genetic engineering software, which will be augmented by software contributed by the user group, and provides access to large, national nucleic acid and protein data bases.

  - The software and data bases are made available, through time-sharing on IntelliCorp's mainframe computer, to members of the academic and nonprofit community involved in genetic engineering research. It is expected that a few of the company's academic and nonprofit timeshare customers may transfer to the BIONET resource.

  - The project is staffed by the company scientists, programmers, and consultants and receives policy direction from an independent national advisory committee.

  - Since the $5.6 million is designed to cover costs of hardware, software, communications, and operations, the cooperative agreement is not expected to result in any material net profit to IntelliCorp.

  - IntelliCorp began operating the BIONET resource in September 1984.

INPUT

INDUSTRY MARKETS

- IntelliCorp derived its fiscal 1984 revenue from the following vertical industry market segments:

  - Discrete and process manufacturing.
  - Banking and finance.
  - Utilities.
  - Federal government.
  - Education.

- IntelliCorp's clients include Alcoa, Arthur D. Little, Johnson Controls, Lawrence Livermore Laboratory, Los Alamos National Laboratory, Raytheon, Sperry, SRI International, 3M, and Union Carbide.

GEOGRAPHIC MARKETS

- IntelliCorp derived its fiscal 1984 revenue from the following geographic markets:

U.S.	93%
Other international	7
	100%

- IntelliCorp's Biotechnology Division, IntelliGenetics, Inc., is located in Palo Alto (CA).

- In December 1984 the company appointed C. Itoh and Company, Ltd. in Tokyo as distributor of its genetic engineering software products in Japan.

COMPUTER HARDWARE

- IntelliCorp has the following hardware in-house:

  - 1 DEC 2060, running under TOPS/20.
  - 1 DEC VAX 11/750 running under VMS.
  - 6 Symbolics 3600s, running under ZetaLisp.
  - 22 Xerox 1108s, running under InterLisp.
  - 1 Xerox 1100, running under InterLisp.
  - 1 LISP Machines' Lambda, running under ZetaLisp.

INTELLIGENT BUSINESS SYSTEMS INC.
246 Church Street
New Haven, CT 06510
(203) 785-0813

William Bird, President
Private Corporation
Total Employees: 26
Revenue, Fiscal Year End
   12/31/84: $1,000,000*

THE COMPANY

- Intelligent Business Systems Inc. (IBS) was founded in August 1983 by William Bird, Dr. Steve Shwartz, and Dr. Roger Schank (of Cognitive Systems Inc.) to market a natural language expert system to wholesalers and distributors. Currently, IBS markets turnkey systems that integrate Amcor Computer Corporation's accounting applications products with EASYTALK I, a natural language system user interface and report generator, on a DEC VAX.

- IBS's initial funding of $1.4 million was received from Prime Capital (Stratford, CT) and Regional Financial Enterprises (New Canaan, CT) on October 21, 1983. IBS received additional funding of $750,000 in October 1984.

- IBS's 27 employees are distributed as follows:

Marketing/sales	8
Software services/customer support	5
Systems engineering and application development	11
General and administrative	2
	26

KEY PRODUCTS AND SERVICES

- All of Intelligent Business System's fiscal 1984 revenue was derived from sales of one product, a turnkey accounting system for wholesale distributors. Six systems have been installed as of December 1984.

- IBS's turnkey system is built around the DEC VAX minicomputer family and packages the following software:

  - EASYTALK I, the company's English natural language interface, was jointly developed with Cognitive Systems Inc. (New Haven, CT).

  - IBS is also licensed to market software products from Amcor Computer Corporation. IBS resells the following Amcor products:

*INPUT estimate

INPUT

- Accounts Receivable.
- Accounts Payable.
- Order Processing and Billing.
- Inventory Control.
- Sales Analysis.
- AMFACS (a financial reporting system).
- AMBASE (an application development DBMS).

- Although the EASYTALK environment is data base independent, IBS developed its current system using Amcor's data base management system, AMBASE, on the DEC VAX 11/730. The unique feature of EASYTALK that differentiates it from other natural language systems is its understanding of the context of English language queries in the business environment. For example, a request for "sales" data from the marketing manager may imply dollars, while the same request from the warehouse manager may imply units.

- Each installation is priced from $55,000 to $150,000 and takes from one to three months on the average to install. Price includes hardware, applications software, a data base management system, EASYTALK, training, and initial maintenance.

INDUSTRY MARKETS

- All of IBS's fiscal 1984 revenue was derived from the wholesale distribution industry segment.

- IBS customers range in size from $1 million to $25 million.

- The company is currently modifying its existing system for use by the discrete manufacturing industry.

- Approximately one-third of IBS's customers replace existing data processing systems, one-third convert from remote computing services, and one-third are automating their businesses for the first time.

GEOGRAPHIC MARKETS

- All of fiscal 1984 revenue was derived within the U.S.

COMPUTER HARDWARE AND SOFTWARE

- The company currently has the following hardware installed in New Haven:

  - 1 VAX 11/785, VMS.
  - 1 VAX 11/750, VMS.
  - 1 VAX 11/730, VMS.

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INPUT

TEKNOWLEDGE INC.
525 University Avenue
Palo Alto, CA 94301
(415) 327-6600

Lee M. Hecht, Chairman and CEO
Private Corporation
Total Employees: 90
Total Revenue, Fiscal Year End
    6/30/84: $2,250,000*

THE COMPANY

- Teknowledge Inc. focuses on selling expert systems software development tools. The company also provides expert systems applications engineering (knowledge engineering) services. In addition, the company offers its clients problem assessment studies and videotaped education and training services. Expert systems (referred to here synonomously as knowledge-based systems) are systems that contain specialized knowledge, both factual and heuristic, and that are able to reach conclusions by applying the specialized knowledge to problems presented by the user. Programming techniques used to develop these systems are the result of research in the academic field of artificial intelligence (AI).

    - Teknowledge was founded in 1981 by computer scientists from Stanford University, Massachusetts Institute of Technology, and The Rand Corporation to provide knowledge engineering consulting and training.

    - In April 1984 General Motors Corporation paid $3 million to acquire 11% of Teknowledge.

- INPUT estimates that Teknowledge's 1984 revenue reached $2.3 million, a 77% increase over estimated 1983 revenue of $1.3 million.

    - Teknowledge's management expects fiscal 1985 revenue to increase substantially over 1984 due to the introduction in Fall 1984 of M.1a, an attractively priced introductory knowledge engineering development system and training module. This product brings down the entry-level price, thus reaching many new users.

- Teknowledge owns and operates one wholly owned subsidiary, Teknowledge Federal Systems Inc., in Thousand Oaks (CA). The subsidiary provides knowledge engineering products and services to the federal government and government contractors. The subsidiary currently has four employees.

*INPUT estimate

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- As of October 1984 Teknowledge had 105 employees segmented as follows:

Software services, customer support, and research and development	52%
Marketing, sales, and general and administrative	48
	100%

- Major competitors for Teknowledge's expert systems software include Intelli-Corp Inc., Texas Instruments, and General Research Corporation. Competition for expert systems-related professional services include Bolt, Beranek, and Newman and IntelliCorp.

KEY PRODUCTS AND SERVICES

- All of Teknowledge's fiscal 1984 revenue was derived from professional services related to the development of custom expert systems and knowledge engineering-related education and training.

  - Near the end of Teknowledge's 1984 fiscal year, the company reversed its direction toward custom software development professional services and changed its focus to marketing system software products and packaged education and training professional services.

  - The company's system software products were introduced late in the fiscal year and as a result did not contribute to fiscal 1984 revenues.

  - Teknowledge management anticipates receiving 50% of its fiscal 1985 revenue from the sale of system software products and 50% from professional services sales. Custom systems development is expected to account for half of the professional services revenues, while education and training is expected to account for the remainder. Much of the anticipated education and training revenues are expected to come from the sale of videotaped education and training packages.

- In June 1984 Teknowledge began marketing system software products specifically designed for the development of knowledge-based expert systems. These software products fall into the area of AI research referred to by Teknowledge as structured selection. Future software products will be developed to cover such other areas of AI as signal interpretation, command and control, design, and planning. Teknowledge's system software products are:

  - System 1 (S.1), introduced in June 1984, is an expert system application development tool and knowledge base management system. The software runs on the Xerox 1100 series and the DEC VAX series computers. A Symbolics implementation will be available in the first quarter of 1985.

    . S.1 is written in the LISP programming language.

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- S.1 ranges in price from $50,000 to $80,000. The price includes maintenance and two weeks of training for two systems engineers. Training for additional engineers costs $5,000 per person.

  - M.1, introduced in June 1984, is a knowledge engineering tool for the IBM Personal Computer. It is designed to allow the professional programmer to grasp the concepts of expert systems design and implement systems on the IBM PC.

    - M.1 is written in the Prolog programming language and runs under PCDOS.

    - The price for M.1 is $10,000. The price includes a five day training session for one system engineer. Training for additional engineers costs $2,500 per person.

  - M.1a, introduced in November 1984, is a scaled down version of M.1 that allows the professional programmer to design prototype and demonstration expert systems on the IBM Personal Computer under PCDOS. In addition to the system software, M.1a includes four hours of videotaped training. This videotaped training is identical to that sold separately as T.1. The price for M.1a is $2,000.

  - Clients who have purchased Teknowledge's system software include General Motors, Mutual Life of Canada, National Cash Register, Elf Acquitaine, and NASA. Over 170 Fortune 500 companies have purchased Teknowledge's products or services.

- Professional services by Teknowledge consist of expert systems software development and videotaped education and training services.

  - Examples of expert systems applications that Teknowledge has designed or is currently developing include an oil drilling advisory system, a computer configuration/order entry system, a prototype advisory and training system for junior bank lending officers, an automobile engineer sub-system maintenance advisory system, and a telecommunications field service office staffing and equipment advisory system.

    - Teknowledge is also currently under contract with General Motors to develop a knowledge-based expert diagnostics system to assist automotive mechanics in the diagnosis of automobile engine malfunctions.

  - A videotaped tutorial on knowledge engineering, called T.1, was released in July 1984. The course comes with four hours of videotaped training, a training manual, and a hands-on exercise diskette which runs on the IBM Personal Computer under PCDOS.

    - In November 1984, at the same time as the release of M.1a, Teknowledge lowered the price of T.1 from its initial price of $2,000 to $595.

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INDUSTRY MARKETS

- Teknowledge derived its fiscal 1984 revenue from a wide range of industries including the following vertical market segments.

    - Discrete and process manufacturing.
    - Banking and finance.
    - Medical.
    - Utilities.
    - Telecommunications.
    - Transportation.
    - Federal, state, and local government.

- During fiscal 1985 the company will target additional cross-industry markets including the engineering/scientific and planning and analysis cross-industry segments.

    - Education and training professional services are targeted toward all Fortune 1000 companies and other professional services organizations. Custom expert systems development services are also targeted to Fortune 1000 companies as well as the federal government through the company's Federal Systems subsidiary.

    - System software products are targeted toward Fortune 1000 companies, large systems houses, and applications developers.

GEOGRAPHIC MARKETS

- Teknowledge derived its fiscal 1984 revenue from the following geographic markets:

U.S.	98%
Europe and Canada	2
	100%

- The company's subsidiary, Teknowledge Federal Systems Inc. is located in Thousand Oaks (CA).

- Teknowledge markets its products in Europe through Framentec, a wholly owned subsidiary of Framatome located in Monaco.

COMPUTER HARDWARE

- Teknowledge has the following computers installed at its headquarters for product development:

    - 2 DEC VAX 750s, operating under VMS.
    - 25 Xerox 1100s and 1108s, operating under InterLisp-D.
    - 40 IBM PCs, operating under PCDOS.
    - 1 Symbolics 3600, operating under Symbolics OS.

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APPENDIX A: DEFINITIONS OF TERMS

- ARTIFICIAL INTELLIGENCE - The academic discipline involving the study of the processes by which humans perceive and assimilate data (and use reasoning to process this data) for the purpose of duplicating these processes within computer systems. Also, this term refers to the computer systems that accomplish these duplicated processes.

- DATA BASE MANAGEMENT SYSTEM - A generalized computer program that handles the mechanics of storing, updating, and accessing data for multiple applications. This definition does not include file management systems designed primarily for simple applications.

- EXPERT SYSTEMS APPLICATIONS - Applications for expert system—a computer system based on a data base created by human authorities on a particular subject. The computer system supporting this data base contains software that permits inferences based on inquiries against the information contained in the data base. Expert systems is often used synonymously with "knowledge-based system," although this latter term is considered to be broader and to include expert systems within its scope.

- EXPERT SYSTEMS GENERATORS - Programmer productivity tools that include data/knowledge base management capabilities, a logic interpretation module (inference engine), and, frequently, window management capabilities. These tools usually generate LISP or PROLOG source code and frequently require a dedicated processor on which to run.

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- FOURTH-GENERATION LANGUAGE - A nonprocedural language that makes it relatively easy for the end user of a computer system to access and process information. A common use of a fourth-generation language is the support of file and data base access. Fourth-generation languages normally feature on-line techniques and the use of menus to set up a request for a study or a report. Two examples of fourth-generation language products used for commercial applications are FOCUS from Information Builders Inc. and RAMIS II from Mathematica Inc.

- KNOWLEDGE-BASED SYSTEM - See term contained within definition for Expert Systems Applications.

- LISP (Programming Language) - Acronym for LISt Processing. LISP is a programming language developed at M.I.T. in the late 1950s and early 1960s. LISP is designed for manipulating symbols and handling connected character strings. These features make LISP useful in mathematical research, in recognition of patterns such as voice patterns, and in the development of compilers for other programming languages. LISP is used in artificial intelligence (AI) development work.

- NATURAL LANGUAGE SYSTEMS - Quasi-knowledge-based systems that contain specialized knowledge of the grammatical and definitive rules of written languages. These systems filter natural language inputs entered by an end user and translate the syntactical structure into a form that the computer can understand. Frequently these systems also contain knowledge about the context of the natural language request.

- OPERATIONS RESEARCH (OR) - A methodology, using a mathematical approach, for solving the operational problems within an organization and for providing management guidance for decision making. The specific objective of operations research is to find the optimal solution to a complex problem utilizing specific resources. Linear programming, probability theory, statis-

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tical analysis, and information theory are all used in operations research. Because of the quantities of data involved in this process, operations research frequently makes use of a computer's processing capabilities.

- PROLOG - A programming language designed to be used for artificial intelligence applications. PROLOG uses problem descriptions to reach solutions based on precise rules. PROLOG, which is an acronym for PROgramming in LOGic, has been adopted by the Japanese as the programming language for their Fifth-Generation Project. Compare PROLOG with LISP, another language used for artificial intelligence applications.

- ROBOTICS - The application of computers to perform tasks normally performed by a human, through use of anthropomorphic devices (arms, hands, etc.).

- SPEECH RECOGNITION - A technology, still in a relatively primitive stage, that recognizes patterns of the human voice and converts these sounds to a form of computer input. Devices currently available that perform speech recognition usually convert analog voice patterns to digital (bit) patterns of ones and zeros. These digital patterns can then be compared with stored word patterns, looking for the closest match. Speech recognition, a rapidly evolving technology, is of potentially great importance to such applications as word processing and the use of computer systems by the blind. This term is synonymous with "voice recognition."

- SPEECH UNDERSTANDING - A natural language system that incorporates speech recognition to identify sound input. The interpretation of different dialects and intonations of these sound inputs differentiates speech understanding from speech recognition. The complexity of this interpretation has limited this technology to the laboratory. Compare this term with "speech recognition."

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APPENDIX B: DATA BASE

- This section contains the data base used in this report. The artificial intelligence market is forecast by application—in Exhibit B-1--and by delivery mode--Exhibit B-2.

  - The application forecast serves as the basis for discussion in this report.

  - The delivery mode forecast is discussed indirectly in the text and is included here only for the sake of completeness.

- Although the forecast values are reported as point estimates reflecting precision to the millions of dollars, the reader should assume a ten-percent margin of accuracy.

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EXHIBIT B-1

ARTIFICIAL INTELLIGENCE MARKET FORECAST
BY APPLICATION, 1985-1990

APPLICATION	USER EXPENDITURES ($ Millions)							AAGR* 1985-1990
	1984	1985	1986	1987	1988	1989	1990	
Expert Systems Applications	$ 45	$ 55	$ 75	$150	$210	$300	$455	53%
Growth Rate		22%	36%	100%	40%	43%	52%	
Expert Systems Generators	$ 10	$ 20	$ 45	$ 80	$120	$170	$230	63%
Growth Rate		100%	125%	78%	50%	42%	35%	
Natural Language Systems	$ 10	$ 40	$ 80	$120	$150	$180	$200	38%
Growth Rate		300%	100%	50%	25%	20%	11%	
Total	$ 65	$115	$200	$350	$480	$650	$885	50%
Growth Rate		77%	74%	75%	37%	35%	36%	

*Average Annual Growth Rate

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MSAI

ARTIFICIAL INTELLIGENCE MARKET FORECAST
BY DELIVERY MODE, 1985-1990

MODE	USER EXPENDITURES ($ Millions)							AAGR* 1985-1990
	1984	1985	1986	1987	1988	1989	1990	
Processing Services	$10	$15	$22	$35	$43	$52	$62	33%
Growth Rate		50%	47%	59%	23%	20%	19%	
Software Products	$10	$20	$38	$67	$96	$137	$195	58%
Growth Rate		96%	94%	75%	44%	42%	43%	
Turnkey Systems	$ 5	$13	$24	$46	$67	$98	$133	59%
Growth Rate		153%	90%	90%	48%	45%	36%	
Professional Services	$40	$68	$116	$203	$274	$364	$496	49%
Growth Rate		70%	71%	75%	35%	33%	36%	
Total †	$65	$115	$200	$350	$480	$650	$885	50%
Growth Rate		77%	74%	75%	37%	35%	36%	

*Average Annual Growth Rate

†Variances are due to rounding.

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MSAI

APPENDIX C

VENDOR QUESTIONNAIRE

1. How do you distinguish artificial intelligence systems from traditional decision support/data processing systems? _____

   _____

   _____

   _____

2. How do you classify the different types of clients that you have? _____

   _____

   _____

   _____

   _____

   _____

3. How do you market your AI products/services? _____

   _____

   _____

   _____

4. Who are your major competitors? (City, State, Phone) _____

   _____

   _____

   _____

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5. How many organizations have purchased your AI products/services over the last year?_____/

What percent of these organizations are Commercial? _____ What percent are Government? _____

Does this percentage reflect the proportion of your revenues from AI products/ services derived form these organizations?   Yes   No

If no, then what proportion of your AI revenues are derived from Commercial versus Government sources?

Number of Organizations _____   Percent of Revenues Derived from:

    Commercial: _____ %   Commercial: _____ %

    Government: _____ %   Government: _____ %

        100%   100%

6a. What revenue growth rate do you expect to experience this year? _____ %

6b. How much of this growth will be derived form new AI clients? _____ %

How much will be derived form existing AI clients buying more products/ services? _____ %

7. How many employees do you have working on AI currently? _____

How many do you expect will be working on AI by the end of 1985? _____

Thank You!

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About INPUT

INPUT provides planning information, analysis, and recommendations to managers and executives in the information processing industries. Through market research, technology forecasting, and competitive analysis, INPUT supports client management in making informed decisions. Continuing services are provided to users and vendors of computers, communications, and office products and services.

The company carries out continuous and in-depth research. Working closely with clients on important issues, INPUT's staff members analyze and interpret the research data, then develop recommendations and innovative ideas to meet clients' needs.

Clients receive reports, presentations, access to data on which analyses are based, and continuous consulting.

Many of INPUT's professional staff members have nearly 20 years' experience in their areas of specialization. Most have held senior management positions in operations, marketing, or planning. This expertise enables INPUT to supply practical solutions to complex business problems.

Formed in 1974, INPUT has become a leading international planning services firm. Clients include over 100 of the world's largest and most technically advanced companies.

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